CEA Standard

Remote Control Command Pass-through Standard for Home Networking

CEA-931-A

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Contents

Table of Figures

Table of Tables

FOREWORD

Users of this standard should be aware that ongoing standardization work in the 1394 Trade Association may have a future impact on this standard. The CEA has stated its intention to harmonize its standards with those developed within the 1394 Trade Association, and likewise the TA has indicated its willingness to coordinate standards development with CEA.

This standard was developed under the auspices of the CEA R-7.5 Audio/Video Networks Subcommittee.

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1. INTRODUCTION

This specification defines a standardized method for communication of certain basic operational functions between devices in an IEEE-1394-based home network[1]. The functions are those typically associated with a device's front panel controls or remote commander. Functions associated with the operation of "IR blaster"[2] arrangements are also accommodated by this method.

2. OVERVIEW AND SCOPE

Machine-to-machine control usually involves modeling the behavior of various elements (sometimes called sub-functions or subunits) within audio/video devices. For this discussion, we use the term "unit" to refer to an audio/video component such as a DVD player or satellite set-top receiver. Any given unit may include within it one or more different subunits. For example, an A/V Receiver may include audio processing subunits (such as amplifiers and filters), audio/video switching subunits, as well as a tuner subunit.

A unit may include DVD playback functionality for example. A fully-featured machine-machine interface (MMI) to the DVD playback unit would involve a device control model (DCM) of the DVD disk player subunit. Device control models typically support control of all aspects of the device and monitoring of the status of all aspects of operation. Full DCM-based device control protocols are often very complex because many devices are, themselves, complex.

Although it does involve commands sent from one machine to another in the home network, this standard takes a simpler approach to solve a simpler problem. This standard may be used to build a remote control unit that is capable of operating any device in the home network that is compliant with the standard. Traditionally, a so-called "universal remote" is a device that emulates the IR pulses needed to control various devices. It must be configured to emit the appropriate codes, or learn them by sampling the output of a remote one wishes to emulate. With the present standard, the function of the universal remote is accomplished by translating, in a controller device such as a DTV, IR codes received from that device's native remote into standard commands on the network bus. The operations defined here apply equally well to devices in the same room as to devices in other rooms accessible via the network.

We consider a home network to be made up of various types of interconnected Audio/Video devices. Some are sources of A/V data; others take in A/V data and process it for output or display (visual or audio). Some devices in the network may function only to control different devices in the network.

The current standard specifies certain commands sent from one A/V device to another in the home network that represent the kinds of functions that are so basic they are often associated with dedicated keys on the remote control unit. The kinds of functions considered here include such things as power on/off, channel up/down, volume up/down, direct entry of channel

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[1] While the commands are specified here in terms of protocols built on the IEEE-1394 standard, the commands could be transported via other standards including other physical layer protocols as they travel from source device to receiving device in the network.

[2] IR Blasters involve infrared emitters on or connected to one device that are programmed to emit infrared pulses emulating the remote control codes recognized by another device. The emitter is placed in proximity of the device to be controlled. Functions such as tuning and operation of a recording device can be performed using an IR Blaster approach.

numbers, and media playback and record controls (play, pause, stop, fast forward and rewind, record). Operations considered for inclusion here communicate a simple user intent across the network, ideally in response to a single, simple user action. The operation is one of a set of operations that enable a remote control associated with any device on the network with video display capability to perform basic functions on any device in the network.

In the protocol described in this standard, the controller device (the one issuing the command) can know whether the target device has implemented the particular function, and whether it was able to perform the indicated action. In some situations, it is up to the user to know whether the action that was performed was actually the desired action, for example, by visual or audio feedback.

The functions specified here have an effect on the target device that is defined by the manufacturer of that device. As an example, the "POWER" control function corresponds to the behavior that would occur if the user hit the Power key on the target device's native remote. A particular target device may use the Power key as "enter low-power standby" or it may be a power toggle. These functions are used in conjunction with visual feedback to the user, for example via an on-screen display or front panel. A source device can create on-screen displays by embedding text and graphics into its video output. Or, if EIA-775-A [3] graphics are used, the on-screen display can be created from bitmaps delivered across the bus.

This standard does not specify the method a controller device might use to determine which target device on the network should be the recipient of a given command. Typically for example, controllers would send video playback-related command to the networked device currently selected as the video source and audio-related commands (mute, volume control) to the device designated as the audio subsystem associated with that source device.

As several different a/v devices in the room may receive infrared pulses from a given remote control unit, and a controller device may translate these pulses into a network command, a given device may receive both a network-delivered command and that same command in the form of infrared pulses. This standard does not specify design requirements to avoid command duplication in such cases[3].

In summary, this standard

- involves network-communicated remote control unit (RCU) commands that convey a simple user intent, usually in response to a single, simple user action;
- does not specify specific behavior required of the target device in response to any given function, although guidance on expected behavior is provided (exact behavior is at the discretion of the device manufacturer); and
- may be used to build a remote control unit that is capable of operating any compliant device in the home network.

2.1 Example Scenarios

Figure 1 shows an example network where the DTV acts as the "controller" device. In this simple scenario, the user has selected the Personal Video Recorder (PVR) on the right as the input source. Using the protocol specified in this standard, a PLAY key on the DTV remote is

[3] It is recommended that in the case a target device determines that the same command has been received both via infrared pulses and via the network, it should reply to the PASS THROUGH command with the ACCEPTED response (even if the infrared pulses arrived first).

interpreted by the DTV as indicating a desire on the part of the user to start playback of the recorded or paused video content. The DTV recognizes the IR pulses, which may be emitted using a proprietary format, as being the PLAY key. The DTV then creates a command delivered on the Home Network backbone to the PVR, indicating "perform your PLAY operation."

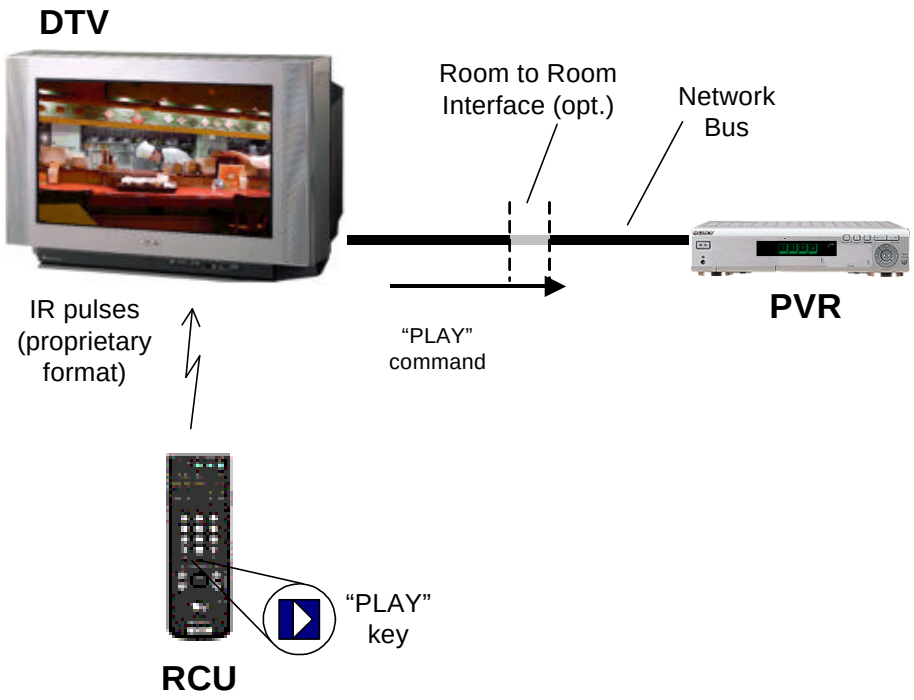

Figure 1. Example Operational Scenario

The Figure shows that the PVR may or may not be in the same room as the DTV receiver—optionally, a room-to-room network interface may separate the two. If the DTV and PVR are in the same room, the protocol defined in this standard offers the features of a "universal remote" in that an RCU from one manufacturer can control a device made by another manufacturer. The conversion between proprietary IR pulse formats and a standard command on the bus makes this possible.

Figure 2 illustrates commands used to interact with and control a source device via a Graphical User Interface the source provides over video or via bitmaps per EIA-775-A [3]. A GUI generated within the source device could be MPEG-2 encoded and delivered across the network bus as compressed video, or EIA-775-A bitmaps could be supplied for the DTV to mix with video. The user can interact with the source device's GUI using the DTV's RCU as long as the GUI uses only the basic navigational keys: the numeric keys (0-9), the arrow keys (up, down, left, right), Enter (or "OK"), and Cancel, and those keys are provided on the DTV remote.

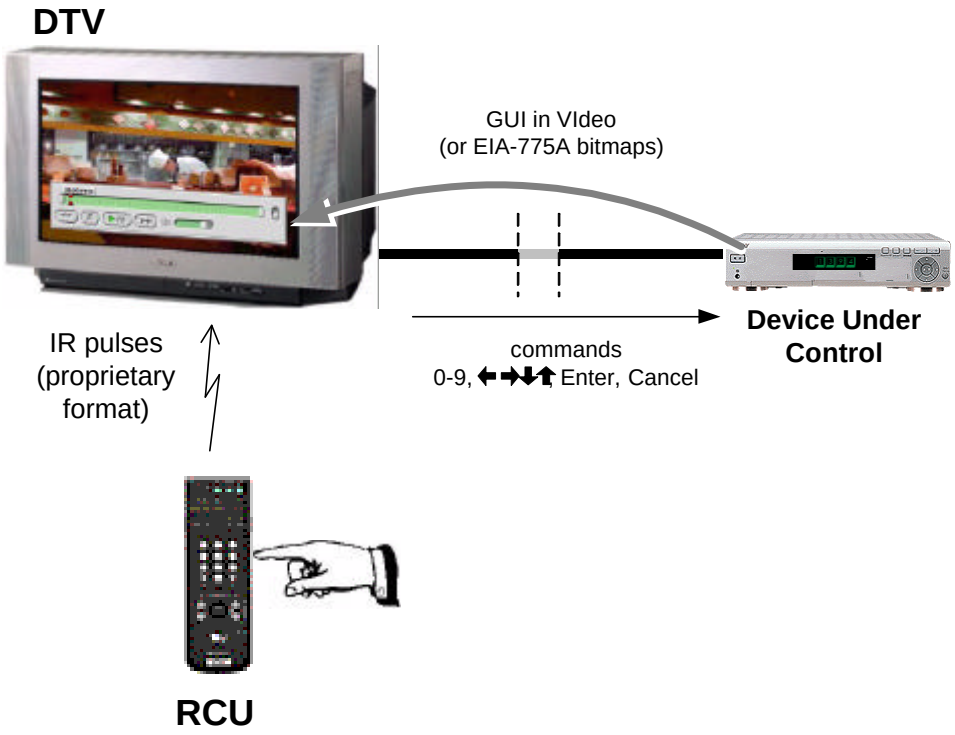

Figure 2. Example Navigation using GUI in Video

2.2 Revision history

Revision A incorporates Version 1.21 of the AV/C Panel Subunit specification [2], which added the *operation_id* values corresponding to "deterministic functions," values 60_{16} through $6A_{16}$. Annex A includes this update of the AV/C document. Informative Section 4.5 in the present revision discusses deterministic functions. Section 4 was expanded to describe requirements for both target and controller devices. Support of the AV/C POWER control commands are now mandatory. Informative Annex B was added to describe an IR Blaster scenario and an example application of CEA-931-A in a digital networked environment.

3. GENERAL

3.1 Normative references

The following standards contain provisions that, through reference in this text, constitute normative provisions of the appropriate sections of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying for the most recent editions of the standards listed in Sec. 3.1.1.

3.1.1 Normative reference list

1. AV/C Digital Interface Command Set General Specification, Version 4.1, TA Document 2002012, 1394 Trade Association, December 11, 2001.

2. AV/C Panel Subunit Specification 1.21, TA Document 2002009, 1394Trade Association.

3.1.2 Normative reference acquisition

1394 Trade Association Documents

- Contact the 1394 Trade Association, 1111 South Main Street, Suite 100, Grapevine, TX, USA; Phone: 817-410-5750; Fax: 817-410-5752; Internet http://www.1394ta.org.

EIA and CEA Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone: 800-854-7179; Fax: 303-397-2740; Internet: http://global.ihs.com; E-mail: global@ihs.com.

3.2 Informative references

3.2.1 Informative reference list

3. EIA-775-A, DTV 1394 Interface Specification, April 2000.

3.2.2 Informative reference acquisition

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone: 800-854-7179; Fax: 303-397-2740; Internet: http://global.ihs.com; E-mail: global@ihs.com.

3.3 Definitions

For the purposes of this document, the following definitions apply.

controller As defined in [1], a device at a serial bus node that sends AV/C commands to control a remote AV/C target device.

direct mode A data transfer mode of the Panel Subunit defined in [2]. In direct mode, the Panel Subunit is responsible for creating the on-screen user interface based on information provided by the target device. User operations are processed in the controller device, and when a UI object (such as a button) is activated, that fact is communicated across the network bus to the target. For details, refer to section 4.4 of [2].

indirect mode A data transfer mode of the Panel Subunit defined in [2]. Allows the Panel Subunit to receive user manipulations but the Panel Subunit is not responsible for display of UI data on the controller screen. The GUI image might be transmitted to the display device as part of the video data transmitted from the target device (e.g. using EIA-799 bitmaps). The Panel Subunit controller conveys user operations to the target by only AV/C PASS THROUGH commands, and works simply like a remote commander of the target device. For details, refer to section 4.5 of [2].

subunit A uniquely identifiable and addressable entity contained within a unit. The

Panel Subunit is a type of subunit defined in [2].

target As defined in [1], a device at a serial bus node that receives and responds to AV/C commands from a remote controller device.

unit The instantiation of an AV/C device. A unit is addressable in a specific way using AV/C commands. A unit may contain zero or more subunits.

3.4 Symbols and abbreviations

ANSI	American National Standards Institute
A/V	Audio/Video
AV/C	Audio/Video Control
CEA	Consumer Electronics Association
DTV	Digital Television
DV	Digital Video
DVCR	Digital Video Cassette Recorder
EIA	Electronic Industries Alliance
GUI	graphical user interface
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
PVR	personal video recorder
RCU	remote control unit
TA	Trade Association
UI	user interface

3.5 Compliance notation

As used in this document, *"shall"* denotes a mandatory provision of the standard. *"Should"* denotes a provision that is recommended but not mandatory. *"May"* denotes a feature whose presence does not preclude compliance that may or may not be present at the option of the implementer. *"Optional"* denotes items that may or may not be present in a compliant implementation.

4. SPECIFICATION

The following sections describe requirements for compliance with this standard. Devices originating commands on the bus issued for the purpose of controlling other devices on the bus are called "controllers." Devices accepting and responding to the control commands defined here are called "targets."

4.1 All devices

Target and controller devices shall support the minimum requirements of the AV/C Digital Interface Command Set General Specification [1].

4.2 Target devices

Target devices shall support the SUBUNIT INFO status command defined in Section 11.3 of the AV/C Digital Interface Command Set General Specification [1] and shall include in the SUBUNIT INFO command status response a *subunit_type* value 09_{16} indicating the presence of a Panel Subunit.

Target devices shall implement the Panel Subunit, Indirect Mode, defined and described in Sections 4.3 and 4.5 of AV/C Panel Subunit Specification [2]. A target device may return a response of "NOT IMPLEMENTED" to the GUI UPDATE status command. Target devices shall respond with "IMPLEMENTED" to the GENERAL INQUIRY command for PASS THROUGH command.

Target devices shall implement the PASS THROUGH control command specified in Section 9 (introduction) and Section 9.4 of AV/C Panel Subunit Specification [2].

Target devices should respond to PASS THROUGH control commands with *operation_id* values corresponding to user operations or deterministic functions applicable to that device. If a given *operation_id* value corresponds to an operation or function that is not applicable to the device, that device should respond to the PASS THROUGH control command with a NOT IMPLEMENTED response.

Target devices shall implement the POWER control command defined in Section 11.1 of [1], and shall support both the Control and Status forms of that command.

4.3 Controller devices

Controllers shall verify that a particular target device supports this specification by:

1. issuing a SUBUNIT INFO AV/C command in accordance with Section 11.3 of [1];
2. verifying the presence of a Panel Subunit (*subunit_type* value 09_{16}) in the response;
3. issuing a GENERAL INQUIRY command for PASS THROUGH command;
4. verifying the response is "IMPLEMENTED."

Implementation guidelines for controllers described in Section 9.4.2 of [2] should be followed.

4.4 Manufacturer-specific commands

One form of the PASS THROUGH command provides a mechanism whereby a manufacturer may deliver nonstandard data related to the remote control key function. The format of the Vendor Unique PASS THROUGH command includes a 24-bit Organizationally Unique Identifier (OUI) code so that any given target device can ensure that the manufacturer-specific bytes contained in the command are understood and supported before processing them. The AV/C specification calls the OUI field *company ID*. The syntax and semantics of bytes following the *company ID* are defined in whatever way the given manufacturer wishes.

A target device shall disregard a Vendor Unique PASS THROUGH command containing an unrecognized value for *company ID*. The Vendor Unique PASS THROUGH command shall not be used to convey RCU key commands that can be represented by one of the standard values for *operation_id* listed in this standard[4].

4.5 Deterministic functions (Informative)

Version 1.21 of the AV/C Panel Subunit specification [2] includes eleven *operation_id* codes corresponding to "deterministic" functions. These functions are distinguished from other codes

[4] If the operation_id list is expanded in a future version of this standard to include new RCU keys, a vendor may continue to use Vendor Unique commands for the new key types to maintain backward compatibility with existing products.

in that the behavior of the target device in response to such a PASS THROUGH command is specified to be predictable. Delivery of a standard “play” command (*operation_id* value 44_{16}), for example, could result in the target device pausing playback if it had been playing when the command arrived. In other words, it might be implemented to toggle between play and pause states. Delivery of the “play function” command (*operation_id* value 60_{16}) however, is specified to result in playback at the given speed regardless of the state the device was in prior to the reception of the command.

For deterministic control over the power state of the target device, the POWER control command defined in Sec. 11.1 of [1] can be used. This method is preferred over the “power” PASS THROUGH command (*operation_id* 60_{16}), again because the operation of this PASS THROUGH command may depend on the prior state of the target device whereas the POWER control command is state-independent.

Deterministic functions can be used in lieu of their non-deterministic counterparts to ensure that all controlled devices behave uniformly in response to user key presses on the controller device. For example, one target device may toggle between playback and pause states in response to successive Pause keys entered on its native remote control unit, while another device does not toggle (staying in the paused state with successive Pause keys). Use of *operation_id* 61_{16} (“pause-play function”) instead of *operation_id* 46_{16} (“pause”) can eliminate this difference.

4.6 Open Issues (Informative)

Even though a target device’s native remote control may include a key with a particular name and function, that key may not correspond with any listed *operation_id*. Even though a device’s remote control unit may include a key named “OK,” for example, the AV/C PASS THROUGH command does not list a key named “OK.” Methods a controller device might use to map an “OK” key to an ENTER or SELECT *operation_id* are not specified here. Situations such as this involving other key functions may arise as well.

Some manufacturers use “ENTER,” some use “SELECT,” while others use “OK” on the RCU for activation of functions and/or termination of data entries. A device may use on-screen textual prompts as part of its user interface. If, for example, an OK key were to be mapped in the controller to the ENTER *operation_id* in the PASS THROUGH command, a prompt such as “Press OK to continue” could be misleading. It is recommended that device manufacturers address this issue with appropriate user instructions.

There will be cases in which the controller’s RCU will not offer a particular key that is present on the target device’s native remote. An example is the Exit key. On RCUs without the Exit key, this function might be implemented by using the Menu key.

ANNEX A

AV/C PASS THROUGH CONTROL COMMAND

(Informative)

The following section is reprinted (with permission) from Section 9.4 of AV/C Panel Subunit Specification Version 1.21 [2] for convenience. Please visit the 1394 Trade Association website at http://www.1394ta.org where a full copy of [2] may be downloaded.

The AV/C Panel Subunit Specification describes both a “direct” and an “indirect” mode of operation. In the direct mode, the controller is responsible for creating and displaying an on-screen UI based on information supplied by the target device. In indirect mode, it is the target device that is responsible for creating the on-screen UI (if any) and the controller simply passes information about key presses to the target. For the purposes of the present standard, only the indirect mode is relevant. Accordingly, several paragraphs in Sec. A.2 pertaining to direct mode operation have not been included here.

A.1. PASS THROUGH CONTROL COMMAND

The PASS THROUGH command is used to convey the proper user operation to the target (transparently to the user). The PASS THROUGH command can be transferred regardless of the state of the target.

The format of the PASS THROUGH control command is as follows.

	msb							lsb
opcode	PASS THROUGH ($7C_{16}$)							
operand[0]	state_flag	operation_id						
operand[1]	operation_data_field_lengh							
operand[2]	operation_data (operation_id dependent)							
:								

Figure A.1 – PASS THROUGH command format

The *state_flag* field indicates the user operation of ‘pressing or releasing a button’, as the remote commander operation. When a button is pressed, the value of this field shall be zero; when released, the value shall be one. A controller usually sends this command twice, i.e. press and release, when user presses and then releases a button. A command with the pressed value is valid for two seconds from the time when a target sends back a response of the command. The controller shall continue sending pressed value with identical operation id value in the *operation_id* field while the command is wished to stay valid. Either if the target has not received the pressed command within two seconds or the target receives the pressed command with another operation id, then the target regards that the released command was sent but missed to receive. In these cases, the target will ignore the released command when the target receives this released command after the time out or reception of the new pressed command.

The “press and hold” user operation could be realized by using press and release operation above. This “press and hold” user operation might mean the different operation from the “press” user operation to the same button. To help the target to decide whether a pressed button is hold or not, it is recommended that the controller have capability of issuing a “release”

command within 300 ms, after it receives a response to the last “press” command. The target should not judge the user operation to be “press and hold” within this 300ms.

The *operation_id* field shows the user operation by each operation id value. See the following table.

Table A.1 – Operation id List

operation_id	user operation		operation_id	user operation
00_{16}	select		40_{16}	power
01_{16}	up		41_{16}	volume up
02_{16}	down		42_{16}	volume down
03_{16}	left		43_{16}	mute
04_{16}	right		44_{16}	play
05_{16}	right-up		45_{16}	stop
06_{16}	right-down		46_{16}	pause
07_{16}	left-up		47_{16}	record
08_{16}	left-down		48_{16}	rewind
09_{16}	root menu		49_{16}	fast forward
$0A_{16}$	setup menu		$4A_{16}$	eject
$0B_{16}$	contents menu		$4B_{16}$	forward
$0C_{16}$	favorite menu		$4C_{16}$	backward
$0D_{16}$	exit		$4D_{16}$	reserved
$0E_{16}$	reserved		:	:
:	:		$4F_{16}$	:
$1F_{16}$	:		50_{16}	angle
20_{16}	0		51_{16}	subpicture
21_{16}	1		52_{16}	reserved
22_{16}	2		:	:
23_{16}	3		$5F_{16}$	:
24_{16}	4		60_{16}	play function
25_{16}	5		61_{16}	pause-play function
26_{16}	6		62_{16}	record function
27_{16}	7		63_{16}	pause-record function
28_{16}	8		64_{16}	stop function
29_{16}	9		65_{16}	mute function
$2A_{16}$	dot		66_{16}	restore volume function
$2B_{16}$	enter		67_{16}	tune function
$2C_{16}$	clear		68_{16}	select disk function
$2D_{16}$	reserved		69_{16}	select a/v input function
:	:		$6A_{16}$	select audio input function
$2F_{16}$	:		$6B_{16}$	reserved
30_{16}	channel up		:	:
31_{16}	channel down		70_{16}	:
32_{16}	previous channel		71_{16}	F1
33_{16}	sound select		72_{16}	F2
34_{16}	input select		73_{16}	F3

Description of user operation

Notes:

The indications on a remote commander or other input device can be different from those shown below as "user operation". Note to use words or symbols that reminds users the targets' performance explained below.

– "Expected operation to be performed by a target" described below applies to *operation_id* values below 60_{16}; it is the recommended basic behavior, and does not limit the possibilities to apply these commands for other purposes.

A.1.1 Key pass-through functions

Table A.2 – Cursor navigation and Menu operations

user operation	Expected operation to be performed by a target
select	Selects the item focused by cursor.
up	Moves cursor upper direction.
down	Moves cursor lower direction.
left	Moves cursor left direction.
right	Moves cursor right direction.
right-up	Moves cursor upper-right direction.
right-down	Moves cursor lower-right direction.
left-up	Moves cursor upper-left direction.
left-down	Moves cursor lower-left direction.
root menu	Displays initial menu to start GUI operation. The menu displayed with this command is target-dependent, so it might be contents menu, setup menu, favorite menu or the other menu, furthermore it may be changed dynamically according to the status of the target. This command may be used to finish GUI operation alternately.
setup menu	Displays set up menu such as option set up. (Can be used as a shortcut.) The menu displayed with this command should be designed to be reached from the initial menu of the target.
contents menu	Displays contents menu. (Can be used as a shortcut.) For example, this command may be used to display the Electric Program Guide (EPG) or the contents list in a storage medium. The menu displayed with this command should be designed to be reached from the initial menu of the target.
favorite menu	Displays user preset menu. (Can be used as a shortcut.) For example, this command may be used to display the list of user preset channel. The menu displayed with this command should be designed to be reached from the initial menu of the target.
exit	Closes current menu and go back previous menu. This command may also be used to finish GUI operation, but a target shall be implemented to be finished GUI operation without this command.

A controller which supports GUI operation shall be implemented with user operations of *select*, *up*, *down*, *left*, *right*, and *root menu*. The GUI of a target should be designed to be controlled all of its available functions by these user operations, if the target doesn't support the direct mode.

Table A.3 – Numerical input operations

User operation	Expected operation to be performed by a target
0 – 9	Input a numerical value.
dot	Used with 0-9 to input numerical value such as a sub channel in US.
enter	Fix the entered numerical value. Target should be implemented to fix the entered value in any way without this command, such as time out.
clear	Cancel the entered numerical value.

Table A.4 – Other operations

User operation	Expected operation to be performed by a target
Channel up	Switches the channel, such as broadcast channel, to upper one, i.e. plus direction in number.
Channel down	Switches the channel, such as broadcast channel, to lower one, i.e. minus direction in number.
previous channel	Switches to the previously selected channel. For example, in case 123 ch was switched to 246 ch, this command can be used as a switcher between 123 ch and 246 ch.
sound select	Used to switch the sound such as multiple language selection.
input select	Used to switch the input signal.
display information	Displays the information about current contents. For example, this command may be used to display the channel number, broadcaster and broadcast time, or recorded date and timecode.
help	Displays help instructions.
page up	Scrolls up the whole screen or part of display.
page down	Scrolls down the whole screen or part of display.
power	Controls the power state of the device alternatively. This command may support to turn the device off only.
volume up	Turns the volume to high.
volume down	Turns the volume to low.
mute	Puts the sound out, and may resume it alternatively or not.
play	Starts playing back the specified content at normal speed.
stop	Stops playing back the content.
pause	Stops playing back the content, and may resume to play it back alternatively.
record	Records the specified stream or content to the specified medium.
rewind	Moves the position toward the beginning of the medium.
fast forward	Moves the position away from the beginning of the medium.
eject	Ejects the medium from the device, and may close the door for loading the medium alternatively.
forward	Switches the contents, such as music tune, or video chapter, which can be reproduced with “play” operation, to the forward one. The 'forward' means future direction in time, plus direction in number, and down direction in a list.
backward	Switches the contents, such as music tune, or video chapter, which can be reproduced with “play” operation, to the backward one. The 'backward' means past direction in time, minus direction in number, and up direction in a list.
angle	Switches the scene of the contents, if it has multi angle contents.
subpicture	Switches or rotates the sub pictures, if it has some sub pictures data.

A.1.2 Deterministic functions

*Operation_id*s in the range 60_{16} to $6A_{16}$ correspond to predictable (deterministic) behavior in the target device. Table 4.5 lists the functions and the corresponding operation to be performed by the target device. As noted below, for certain deterministic functions the *operation_data* field provides data pertinent to the function. For those functions that do not have associated *operation_data*, the *operation_data_field_length* shall be zero. The *state_flag* field shall be set to zero for deterministic functions.

Table 4.5 – Deterministic functions

function	Operation to be performed by a target
play function	Starts playing back the specified content at the speed and direction specified in the operation_data field. If sent more than once, the device shall continue playing at the speed and direction specified in the operation_data field.
pause-play function	Pauses playback. If sent more than once, the device shall remain in the paused state.
record function	Shall result in device entering the state of recording from selected input. If sent more than once, the device shall remain in the record state and no interruption in recording shall occur.
pause-record function	Pauses the recording. If sent more than once, the device shall remain in the paused state.
stop function	Shall result in stopping from any transport state. If sent more than once, the device state shall remain in the stopped state.
mute function	Mutes audio output. If sent more than once, audio output shall rema;in muted.
restore volume function	Restores audio output to the value in effect before last time muted.
tune function	Tunes to the channel number specified in the operation_data field.
select disk function	Selects physical media as specified in the operation_data field.
select a/v input function	Selects the audio/video input given in the operation_data field.
select audio input function	Selects the audio input given in the operation_data field.

A.1.2.1 Play function

This function is intended for any device capable of playing back stored audio or a/v content. Play audio or audio/video content forward or backwards at a speed indicated in the *playback_speed* field formatted in accordance with Figure A.2. *Operation_data_field_length* is 01_{16}.

	msb							lsb
operand[2]	playback_speed							

Figure A.2 – Field format for "play function" subcommand

Playback_speed is an unsigned integer number coded in accordance with Table 4.6 that indicates the speed of playback.

Table 4.6 – Playback Speed

playback_ speed	Playback Mode	support level	Description
0x30	NEXT FRAME	R	Playback the next sequential frame or field
0x31	SLOWEST FORWARD	R	Playback at a special effect speed
0x32	SLOW FORWARD 6	O	“
0x33	SLOW FORWARD 5	O	“
0x34	SLOW FORWARD 4	O	“
0x35	SLOW FORWARD 3	O	“
0x36	SLOW FORWARD 2	O	“
0x37	SLOW FORWARD 1	O	“
0x38	X1	M	Playback at normal speed
0x39	FAST FORWARD 1	O	Playback at a special effect speed
0x3A	FAST FORWARD 2	O	“
0x3B	FAST FORWARD 3	O	“
0x3C	FAST FORWARD 4	O	“
0x3D	FAST FORWARD 5	O	“
0x3E	FAST FORWARD 6	O	“
0x3F	FASTEST FORWARD	M	“
0x40	PREVIOUS FRAME	R	Playback the previous sequential frame or field
0x41	SLOWEST REVERSE	R	Playback in reverse at a special effect speed
0x42	SLOW REVERSE 6	O	“
0x43	SLOW REVERSE 5	O	“
0x44	SLOW REVERSE4	O	“
0x45	SLOW REVERSE 3	O	“
0x46	SLOW REVERSE 2	O	“
0x47	SLOW REVERSE 1	O	“
0x48	X1 REVERSE	O	Playback at normal speed in reverse
0x49	FAST REVERSE 1	O	Playback in reverse at a special effect
0x4A	FAST REVERSE 2	O	“
0x4B	FAST REVERSE 3	O	“
0x4C	FAST REVERSE 4	O	“
0x4D	FAST REVERSE 5	O	“
0x4E	FAST REVERSE 6	O	“
0x4F	FASTEST REVERSE	M	“
0x65	REVERSE	O	Playback at normal speed in reverse
0x6D	REVERSE PAUSE	O	Pause in reverse playback
0x75	FORWARD	M	Playback at normal speed
0x7D	FORWARD PAUSE	M	Pause in playback

Support levels in the table are as follows: O=optional; R=recommended; M=mandatory.

A.1.2.2 Tune function

Tune to the one- or two-part channel number indicated in the operation data field. For devices with tuners. Data is formatted in accordance with Figure A.3. *Operation_data_field_length* is 04_{16}.

	msb							lsb
operand[2]	two_part	reserved			major_channel_number (MSB)			
operand[3]	major_channel_number (LSB)							
operand[4]	reserved				minor_channel_number (MSB)			
operand[5]	minor_channel_number (LSB)							

Figure A.3 – Field format for "tune function" subcommand

When the *two_part* flag is set to one, the *major_channel_number* and *minor_channel_number* fields are interpreted as a two-part channel number. When this flag is set to zero, the channel number is a one-part number whose value is given in *major_channel_number*. The *minor_channel_number* field shall be ignored when the *two_part* flag is set to zero.

When the operation involves tuning to a two-part channel number, the *major_channel_number* field represents the major channel number (see [R18]). When the operation involves tuning to a one-part channel number, this field represents the one-part channel number.

When the operation involves tuning to a two-part channel number, the *minor_channel_number* field represents the minor channel number per [R18].

The target device should attempt to tune to the indicated channel number even if the channel is currently not available (not broadcasting or not avilable in the virtual channel table). For timed recording applications, the tune command might occur just prior to a channel coming into existence (or coming on-air), so proper acquisition of the channel must occur at the time the channel becomes available.

A.1.2.3 Select disk function

This function selects the disk number indicated in the operand field. Data is formatted in accordance with Figure A.4. For target devices with multiple selectable disks. *Operation_data_field_length* is 02_{16}.

	msb							lsb
operand[2]	disk_number							
operand[3]								

Figure A.4 – Field format for "select disk function" subcommand

The *disk_number* is an unsigned integer number in the range 1 to 65,535 that identifies the disk number to be selected in the target device.

A.1.2.4 Select A/V input function

This function selects the audio/video input signal number indicated in the operand field. Data is formatted in accordance with Figure A.5. For target devices that offer multiple a/v inputs. *Operation_data_field_length* is 01_{16}.

	msb							lsb
operand[2]	audio_video_input_number							

Figure A.5 – Field format for "select A/V input function" subcommand

The *audio_video_input_number* is an unsigned integer number in the range 1 to 255 that identifies the audio input number to be selected in the target device.

A.1.2.5 Select audio input function

This function selects the audio input signal number indicated in the operand field. For target devices that offer multiple audio inputs. Data is formatted in accordance with Figure A.6. *Operation_data_field_length* is 01_{16}.

	msb							lsb
operand[2]	audio_input_number							

Figure A.6 – Field format for "select audio input function" subcommand

The *audio_input_number* is an unsigned integer number in the range 1 to 255 that identifies the audio input number to be selected.

A.1.3 Function keys

Table A.7 – Function key operations

User operation	Expected operation to be performed by a target
F1 – F5	Input function keys of F1 – F5

*Operation_id*s for function keys are defined for the purpose of operating actions that are uniquely designed for specific AV device type or a particular device to be controlled by a general purpose controller.

Function key operation is flexibly used according to the type of device or the character of the device, and therefore a particular action of a target is not defined to each function key in this specification. Since function keys are defined for universal use, an industry group may assign a function key to the action that may be commonly shared with the AV devices in the same type. In another case, a device may allow a user to assign his/her favorite action to a function key as short-cut operation. Annex C in [2] describes some examples for function key operation.

The function keys make it possible to control actions that are uniquely assigned by a device from a general purpose controller. A vendor of a device shall present to the user which action is assigned to which function key in some method; such as to describe in the device's users manual, present in OSD, or display on the device.

Table A.8 – Vendor unique operation

User operation	Expected operation to be performed by a target
vendor unique	Used to convey vendor unique information to a target. Information which can be conveyed with other operation id shall not be handled.

The *operation_data_field_length* field contains the number of bytes in the *operation_data* field. If there is no *operation_data* field, the value of this field shall be zero. In this version of the specification, the *operation_data* field is defined only for the "vendor unique" operation. So the other operation has no *operation_data* field and its *operation_data_field_length* field value is zero in the command frame.

The following table shows the value of each field in CONTROL command, NOT IMPLEMENTED response, ACCEPTED response and REJECTED response. INTERIM response should not be used.

Table A.9 – Command and response frame for PASS THROUGH control command

field	CONTROL command frame	ACCEPTED response frame	REJECTED response frame	NOT IMPLEMENTED response frame
state_flag	press/release state	←	←	←
operation_id	type of operation	←	←	←
operation_data	depends on operation_id	←	←	←

Note: "← " means the same value as the previous frame

A target sends ACCEPTED response when it is implemented with the requested operation, and sends NOT IMPLEMENTED response when it is not implemented. A target should send ACCEPTED response no matter whether or not the operation can be executed at the moment. A target may send REJECTED response, for example, when it is implemented the requested operation but has been reserved by another controller with RESERVE command.

A.2. OPERATION DATA FIELD FORMAT

A.2.1 Vendor unique

When the value of *operation_id* field is $7E_{16}$, which means "vendor unique", the *operation_data* field is defined as following table shows.

Address	Contents
$00\ 00_{16}$	company ID
$00\ 01_{16}$	
$00\ 02_{16}$	
$00\ 03_{16}$	vendor dependent information
:	

Figure A.7 – Operation_data (operation_id = $7E_{16}$) field format

The *company id* field shows the manufacturer that defined the vendor unique user operation. The *company id* value is obtained from the IEEE Registration Authority Committee (RAC)[5]. The most significant part of the *company id* is stored in address 0000_{16} and the least significant part in address 0002_{16}.

A.3. CONTROLLER IMPLEMENTATION GUIDELINE FOR PASS THROUGH COMMAND

When the user manipulates the physical or logical remote commander, e.g. IR remote commander or commander that emulates IR remote commander using GUI, the controller may

[5] See http://standards.ieee.org/regauth/oui/index.shtml.

issue PASS THROUGH command or may trap the user operation according to the controller's application.

However implementation guidelines for PASS THROUGH command placed on a controller are as follows:

- A PASS THROUGH command provides a simple and common mechanism to control the target. However, in principle, an application in a controller should not use a PASS THROUGH command as a substitute for any subunit or unit command, because the target behavior to a PASS THROUGH command may not be the same as that controller expects.
- Basically, a PASS THROUGH command intends to be used in the following cases:

  (1) When the controller displays the stream data and the user operates a remote commander, the controller should first send the PASS THROUGH command to the source device of the stream data.

  (2) When the user selects a target device and operates a remote commander, the controller should send first the PASS THROUGH command to the selected device.

  Afterwards the controller should send the other unit or subunit command when the target returns NOT IMPLEMENTED response, if the controller can surely recognize the other suitable unit or subunit command for the user manipulation.
- Basically, a PASS THROUGH command does NOT intended to be used in the following cases:

  (1) When an application of the controller controls plural targets at the same time, e.g. dubbing, the controller should send the unit or subunit command to these targets.

  (2) When the controller wants to control a legacy device that doesn't implement PASS THROUGH command, the controller should first send the unit or subunit command to the legacy device.
- Usage in the scenario for the indirect mode;
  CONDITION: The controller has a remote commander, whose buttons correspond to user operations defined in Table A.1, and the target supports the indirect mode.

  (1) When the user pushes the button on the remote commander, it should first issue the PASS THROUGH command with the operation_id according to the selected kind of the button.

ANNEX B

APPLICATION SCENARIOS

(Informative)

This annex presents application scenarios for CEA-931-A to illustrate some potential benefits to users of networked audio/video devices in the home.

B.1. IR BLASTER FUNCTIONALITY

A device equipped with an IR Blaster is able to create and emit the infrared Remote Control Unit pulses of a device it wishes to control. Generally, the user must configure the IR Blaster-equipped device to identify the manufacturer and model number of the device to be controlled, as this information cannot be predetermined. The following sections illustrate how audio/video devices that support CEA-931-A can perform the same functions implemented today using IR Blasters.

B.1.1 Analog setup using IR Blasters

Figure B.1 diagrams a typical non-networked analog home audio/video equipment setup consisting of a video display, cable set-top box[6] video source, a hard-disk personal video recorder (PVR), and an analog VCR. The VCR can be used as a video source to play taped material, or it can be used by the PVR for archival storage of programs captured to hard disk.

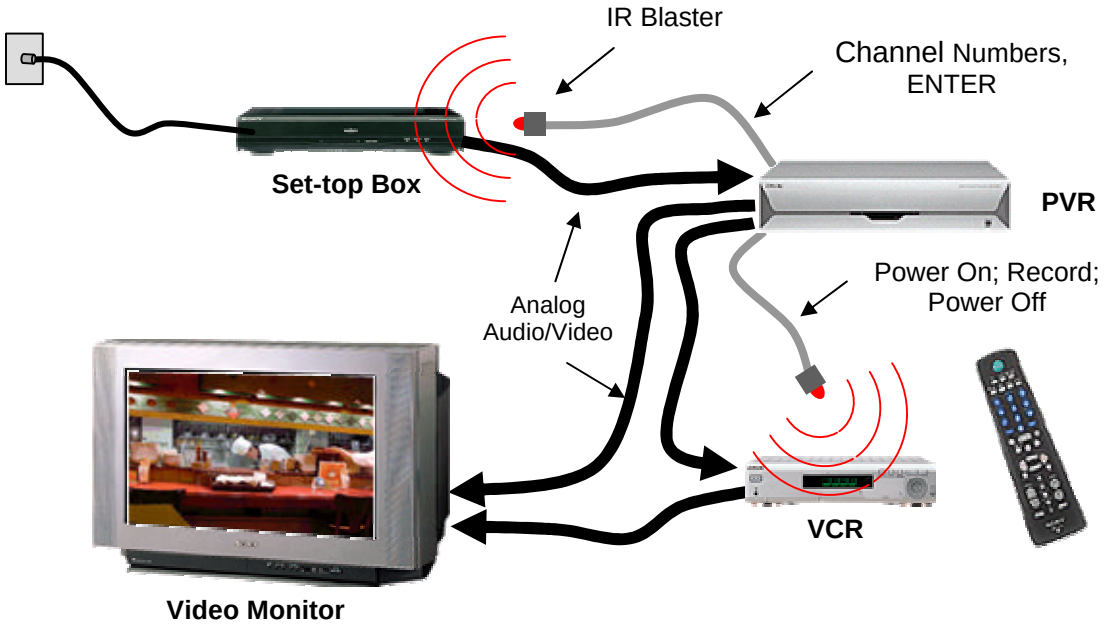

Figure B.1 – IR Blaster Scenario with Analog Interconnects

[6] A cable box is shown, but it could just as well be a satellite or terrestrial digital television box

The heavy black lines in the Figure represent analog audio/video connections. The PVR offers an electronic program guide feature, allowing the viewer to peruse the schedule of current and future programming on the available channels and select programs to watch and/or record. If a program is found in the guide, the set-top box must be made to tune to the channel carrying that program. Such a channel change could be made manually by user interaction with the set-top-box, but it is more convenient if the PVR can emulate the infrared pulses from the set-top's own remote control unit (RCU) and emit the proper codes to effect the channel change. This technique is often called the "IR Blaster" approach and it is diagrammed in the Figure.

Physically, an IR Blaster consists of an infrared emitter on the end of a length of two-conductor cable. One end of the cable is plugged into the device that will act as the controller, and the emitter end is placed nearby the device being controlled. To change channels on the set-top box, the PVR must emulate RCU pulses for numeric digits and (typically) the "ENTER" key.

A typical hard-disk-based PVR allows the user to transfer stored material to tape. As before, it would be possible for the user to turn on the VCR and manually start the recording (and also stay around to the end to stop it). With a second IR Blaster, however, the PVR can emulate the VCR's RCU and effect the Power-on, Record, and Stop functions.

While usable, the IR Blaster approach in this application suffers from a number of drawbacks, including:

- complexity of user setup
    - extra wires are involved
    - when setting up the controller, the user must identify by manufacturer and model name each piece of equipment to be controlled (if the equipment is not listed, the IR Blaster function may not operate properly)
    - pulses cannot be emitted with too short a time interval in between or they may not be properly handled by the target device; a trial and error process may be required to set the proper timing
- potential unreliability, as the emitted IR pulses may be blocked or interfered with, the emitter may not be in proper position (too close or too far away), or the sequence may be sent without enough time between keys
- the various pieces of equipment must be in close physical proximity due to cable length limitations

B.1.2 Networked PVR Example

Figure B.2 shows the same arrangement, but this time the various A/V units support IEEE 1394 interconnects and the CEA-931-A protocol. Since we have moved to the digital world, the VCR is replaced by a unit called "archival storage." Such a device may or may not offer removable storage media.

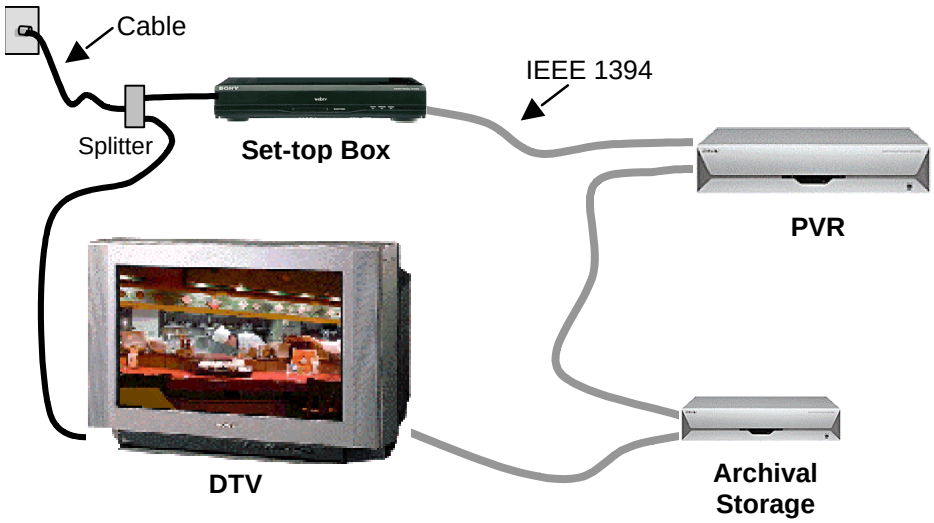

Figure B.2 – Networked PVR Example

To ensure the Archival Storage unit is properly powered up and ready to receive networked commands, the PVR can query its power status using the POWER status inquiry[7]. If it is not already powered up, a POWER control command to set the power status to "on" can be delivered prior to issuing any other commands.

With the arrangement of Figure B.2, and assuming the devices support CEA-931-A, the PVR can now tune the set-top box directly using the PASS THROUGH control command Tune Function, *operation_id* 67_{16}. It can start and stop the recording function in the Archival Storage unit using the Record Function and Stop Function (*operation_id* values 62_{16} and 64_{16} respectively).

In Figure B.2, the cable also runs directly to the DTV receiver, which in this case is able to tune cable channels and output them on the 1394 bus. The PVR therefore has a choice of either the cable box or the DTV receiver's tuner to use as a video source and can issue tune commands to either one.

[7] as defined in the AV/C Digital Interface Command Set General Specification

B.2. RCU KEY PASS-THROUGH

Figure B.3 shows the same equipment as before. The Figure illustrates RCU key pass-through, showing how keys on the DTV RCU may be converted to PASS THROUGH commands by the DTV and delivered across the network to the selected target (source) device. In the example shown, a PAUSE key is pressed on the RCU, and the DTV has converted it into a PASS THROUGH "Pause Function" command (*operation_id* 61_{16}). In the figure, the delivery over the network of the Pause Function command is shown as a heavy dotted line.

At any given time, the DTV receiver can display video from one of several different source devices. The choice of video source may be made by viewer interaction with the receiver. When a key is pressed on the DTV RCU that does not correspond to a native function (one usable by the receiver itself), the DTV can convert it into the corresponding PASS THROUGH control command and deliver it to the currently selected source device on the network.

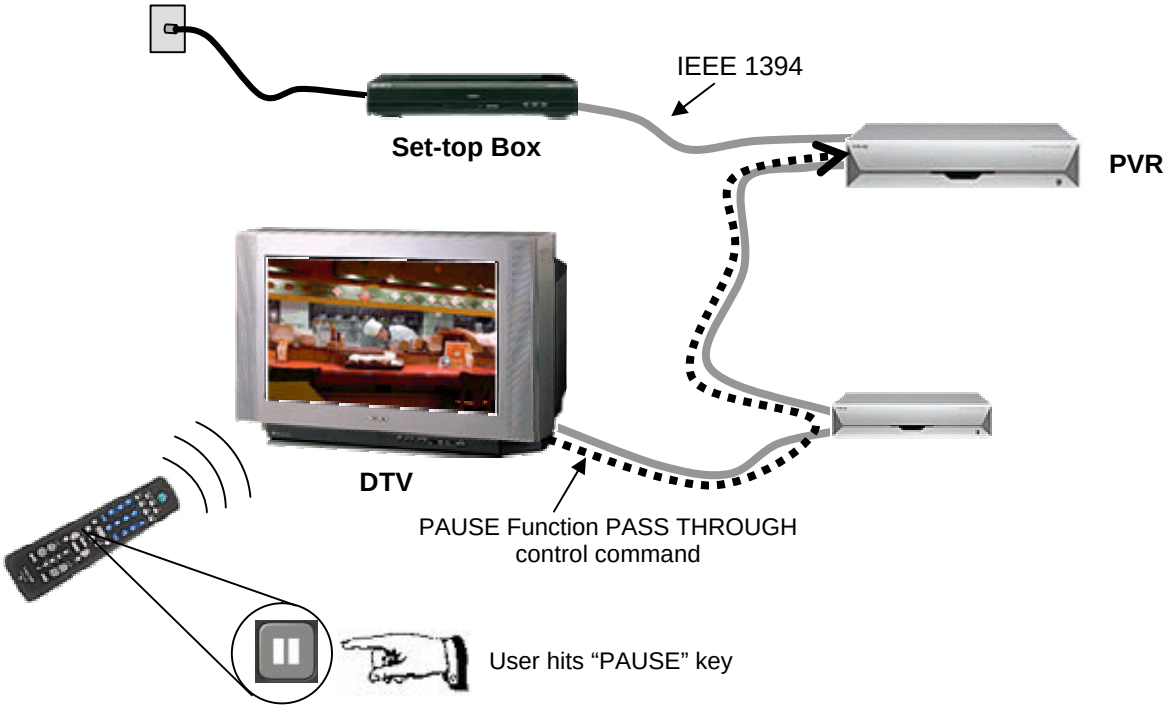

Figure B.3 – RCU Key Pass-through

CEA Document Improvement Proposal

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